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PREVALENCE OF ELEVATED SERUM CHOLESTEROL
AMONG ACTIVE DUTY NAVY PERSONNEL

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Summary

Problem

Cardiovascular disease is the leading cause of death in the United States, costing billions of dollars annually in health care and associated costs. Epidemiological studies provide strong evidence for a causal link between increased blood cholesterol levels and increased risk of coronary heart disease (CHD). The U.S. Navy is seeking to reduce the incidence of CHD among its members by identifying and treating individuals with elevated serum cholesterol. Research is needed to establish baseline prevalence rates of hypercholesterolemia, correlates of undesirable cholesterol levels, patterns of change, and efficacy of interventions.

Objective

The specific objectives of this study were to (a) replicate and extend earlier findings of cholesterol levels at different age groups in the Navy; (b) compare risk rates using recently promulgated Navy standards with risk rates using more traditional cutpoints; (c) estimate prevalence of risk on total cholesterol (TOTCHOL), LDL-cholesterol (LDL), HDL-cholesterol (HDL), triglycerides (TRIG), and the TOTCHOL:HDL ratio; (d) examine prevalence of risk among various subgroups; (e) compare Navy patterns with national norms; and (f) draw attention to some of the problems inherent in interpreting these data. Keywords: Cholesterol, Health Promotion, Physical Readiness Program, Serum, Navy Personnel, Coronary heart disease (JG)

Approach

Blood lipid profiles were collected for 5,487 active duty men and women presenting for routine physical examinations in the catchment areas of two major naval hospitals. Fasting blood lipid values were obtained for TOTCHOL, HDL, and TRIG; LDL was computed from these. The majority of analyses used the Navy's total cholesterol risk cutpoints (>200 mg/dL for ages 18-24, >220 mg/dL for ages ≥25) to determine individuals at risk for premature CHD. Certain comparative analyses also used cutpoints set by the National Institutes of Health (NIH) and those set by the National Cholesterol Education Program (NCEP).

Results

In general, serum cholesterol levels were somewhat elevated across age groups, though the overall age-adjusted mean (196 mg/dL) was within the standards set by the NCEP panel. There was a significant difference in means between the two hospitals providing data for the study. Mean cholesterol levels rose with age and were higher at every age group than those reported in a recently published Navy report. Group patterns for TOTCHOL levels were similar to age-adjusted national norms except for the lower rates observed among Navy women 35-44 years old. Men had higher TOTCHOL, LDL, and TRIG and lower HDL than did women. About 30% of the age-adjusted sample were at risk on TOTCHOL; the percent at risk increased when LDL and HDL risk were taken into account as well. The percent at risk on TOTCHOL climbed from 25% in the youngest age group to 58% in the oldest. It was higher among men, enlisted personnel, and those with less than a high school education; no differences were found for race or community (ship/shore). When compared with data obtained from the private sector for ages 20-44 only, the Navy (ages 20-44) was significantly higher in total percent at risk (36.4% vs. the nation's 28.2%). Results based on the Navy cutpoints were very similar to those based on the NIH guidelines, but estimated percent at risk was higher when computed using the NCEP cutpoints.

Conclusions

The cholesterol levels observed in this Navy sample (mean age=33.6 yrs), like those in the nation at large, were above levels recommended by health experts, with a substantial number of individuals at increased risk for CHD. Lack of standardization in laboratory methodology may account for the mean TOTCHOL difference found between hospitals in this study as well as for differences between the present results and those recently reported in a similar Navy study. Because these results cannot be properly interpreted until the cholesterol data have been proven reliable, it is recommended that the Navy make laboratory standardization a priority in its cholesterol screening program. Choice of risk cutpoint, which is as much a management strategy as a medical decision, has a significant impact on the determination of prevalence rates and should be carefully reviewed as research in the field progresses.

Introduction

Cardiovascular disease is the leading cause of death in the United States, accounting for almost half of the nation's mortality and costing nearly \$90 billion dollars annually.¹ Both humanitarian and financial concerns contribute to the growing interest in identifying individuals at risk for developing premature cardiovascular disease, especially insofar as that risk can be modified downward. Epidemiological studies, most notably the Lipid Research Clinics (LRC) Coronary Primary Prevention Trial, provide strong evidence for a causal link between increased blood cholesterol levels and increased risk of coronary heart disease (CHD).² In the wake of such studies, cholesterol screening programs and nutrition education campaigns have appeared in private and public sectors alike.

In December 1984, the National Institutes of Health (NIH) Consensus Development Conference on Lowering Blood Cholesterol³ chose to define moderate- and high-risk levels of blood cholesterol that were adjusted for age (see Table 1). Using these NIH values, the second National Health and Nutrition Examination Survey (NHANES II)⁴ reported that approximately 35% of civilian adults nationwide exceeded acceptable cholesterol levels and were at risk for premature coronary disease. More recently, an expert panel for the National Cholesterol Education Program (NCEP)⁵ recommended uniform risk cutpoints for adults of all ages (Table 1). According to these guidelines, all adults 20 years of age and older should maintain a serum cholesterol value below 200 mg/dL. In addition, because the causal relationship between cholesterol and CHD now appears to rest largely with elevated levels of the low-density lipoprotein (LDL) fraction, the panel provided guidelines for LDL-cholesterol risk levels as well (Table 1). The NHANES II data show that more than 55% of the nation's civilian population have total cholesterol levels exceeding the NCEP panel's recommendation, and were LDL levels taken into account as well, the estimated prevalence of hypercholesterolemia would be even higher. (Other lipid values shown in Table 1 are explained below.)

TABLE 1
OVERVIEW OF VARIOUS BLOOD LIPID RISK CUTPOINT VALUES

<u>Total Cholesterol (TOTCHOL)</u>		
<u>NIH, 1984</u>		
<u>Age</u>	<u>Moderate Risk</u>	<u>High Risk</u>
20-29 yrs	201-220 mg/dL	>220 mg/dL
30-39 yrs	221-240 mg/dL	>240 mg/dL
40 yrs & older	241-260 mg/dL	>260 mg/dL
<hr/>		
<u>NCEP, 1987</u>		
<u>Age</u>	<u>Moderate Risk</u>	<u>High Risk</u>
20 yrs & older	200-239 mg/dL	240+ mg/dL
<hr/>		
<u>NAVY, 1989</u>		
<u>Age</u>	<u>At Risk</u>	
18-24 yrs	>200 mg/dL	
25 yrs & older	>220 mg/dL	
<hr/>		
<u>LDL-Cholesterol (LDL)</u>		
<u>Age</u>	<u>Moderate Risk</u>	<u>High Risk</u>
20 yrs & older	130-159 mg/dL	160+ mg/dL
<hr/>		
<u>HDL-Cholesterol (HDL)</u>		
<u>Age</u>	<u>At Risk</u>	
20 yrs & older	< 35 mg/dL	
<hr/>		
<u>Triglyceride (TRIG)</u>		
<u>Age</u>	<u>Moderate Risk</u>	<u>High Risk</u>
20 yrs & older	250-500 mg/dL	>500 mg/dL
<hr/>		
<u>TOTCHOL:HDL Ratio</u>		
<u>Age</u>	<u>At Risk</u>	
18 yrs & older	>5.0	

Like a growing number of organizations, the U.S. Navy is seeking to reduce the incidence of CHD among its members by identifying and treating individuals with elevated cholesterol. The Navy recently promulgated its own standards for cholesterol risk levels,⁶ which are presented in Table 1. Research is needed to establish baseline and longitudinal data bases for determining prevalence of hypercholesterolemia among Navy personnel and selected subgroups, correlates (or predictors) of undesirable cholesterol levels, patterns of change, and efficacy of interventions. Blair and his

colleagues⁷ have initiated this research effort, reporting that 48% of their Navy sample (n=1,000 active duty men and women, ages 20-50+) had cholesterol levels equal to or greater than 200 mg/dL. The purpose of the present study was to (a) replicate those initial findings and extend them to a broader Navy sample; (b) compare risk rates using the new Navy standards with those using the more traditional cutpoints; (c) estimate prevalence of risk on total cholesterol, LDL-cholesterol, HDL-cholesterol, triglycerides, and the total cholesterol:HDL-cholesterol ratio; (d) examine prevalence of risk among various subgroups; (e) compare Navy patterns with national norms; and (f) draw attention to some of the problems inherent in interpreting these data.

Methods

Participants

During a 3-month period from mid-April to mid-July 1989, blood lipids data were collected for all active duty personnel presenting for routine physical examinations in the catchment areas of two major naval hospitals. Data from inpatient admissions and outpatient visits for medical problems (vs. routine physical exams) were not included in the sample. Laboratories at both hospitals (Lab 1 and Lab 2) employed an enzymatic procedure with blood serum to determine cholesterol concentrations. Lab 1 used a Technicon SMAC analyzer, which one study found to yield higher cholesterol values than the LRC standard results.⁸ Lab 2 used a Hitachi 736-30, which has not been evaluated, though the Hitachi 737 was tested in a different study and found acceptable.⁹ While internal quality control procedures are operative at both laboratories, the Navy does not yet participate in an external quality control program to standardize methods among its medical centers.

Variables

Fasting blood lipid values were obtained for total cholesterol (TOTCHOL), high-density lipoprotein (HDL) cholesterol, and triglycerides (TRIG); the LDL-cholesterol variable was computed from these using the

formula $LDL = TOTCHOL - HDL - (TRIG/5)$.⁵ Demographic information was obtained for participants by matching their Social Security numbers from the cholesterol records with those on the Navy's Master Enlisted Record and Master Officer Record, resulting in a final sample of 5,487 active duty men and women. Nonmatches (about 16%) were attributed to status other than Navy active duty (e.g., Navy retired or Marine Corps active duty). Demographic profiles for the total sample and for both laboratories are presented in Table 2.

TABLE 2
DEMOGRAPHIC STATISTICS FOR NAVY SAMPLE AND TOTAL NAVY

Variable	Total Sample	Lab 1	Lab 2	Total Navy (1988)
<u>N OF CASES</u>	5487	1977	3510	608,102
<u>MEAN AGE</u> (yrs)	33.6	33.3	33.8	27.0
<u>SEX</u> (%)				
Men	93	92	93	91
Women	7	8	7	9
<u>RACE</u> (%)				
White	78	83	76	79
Black	11	12	10	15
Other	11	5	14	6
<u>RANK</u> (%)				
Officer	24	24	23	12
Enlisted	76	76	77	88
<u>EDUCATION</u> (%)				
<12 years	6	6	5	6
12 years	58	58	58	73
>12 years	36	35	37	21
<u>COMMUNITY</u> (%)				
(enlisted only)				
Ship	47	54	44	48
Shore	53	46	56	52

Analyses

Most of the statistics presented below are descriptive in nature, emphasizing the percent of individuals found to be at risk in various subgroups. Comparative statistics such as chi square and t-ratio were also

computed when appropriate. However, tests of significant differences between groups were not always possible, such as when comparing Navy cholesterol rates with published results from other studies. Analyses were performed using the SPSS-X statistical package.¹⁰

The Navy's recommended risk cutpoints have been used in most of the analyses reported below. The NIH Consensus Conference cutpoints have been used where comparisons with national norms (from NHANES II) were desired. The NHANES II sample ($n=11,864$ with blood cholesterol data) is representative of the noninstitutionalized civilian adult population of the United States between 1976 and 1980. Individuals in the present Navy sample who were 18-19 years of age ($n=63$) were excluded from normative comparisons with the national sample because the NHANES II norms begin with age 20. Furthermore, the norms themselves, based on ages 20-74, were age-adjusted in these analyses to ages 20-54 (or 20-44 in some cases) so as not to bias comparisons with the younger Navy sample. Age-adjustment was accomplished simply by recomputing the total N for the age groups of interest (e.g., n for ages 20-24, 25-34, 35-44, and 45-54, inclusive), calculating the number of people at risk in each age group (using the n and percent at risk reported for each group), and dividing the total N at risk (in ages 20-54) by the recomputed total N for those ages. The reader should also note that small cell sizes in certain Navy subgroups (for example, older women) sometimes required limiting analyses to adequately represented groups within the Navy sample itself.

Emphasis has been given to total cholesterol values and overall percent of individuals at risk due to elevated TOTCHOL. However, the NCEP panel noted that elevated LDL-cholesterol and low HDL-cholesterol (<35 mg/dL) are also major independent risk factors which should be considered when evaluating an individual's lipid profile. An elevated triglyceride level (>250 mg/dL)⁵ and a high TOTCHOL:HDL ratio (>5.0)⁶ are additional risk factors. All of these factors have been included in Table 1 and in some of the analyses that follow.

Results

Mean Blood Lipid Values

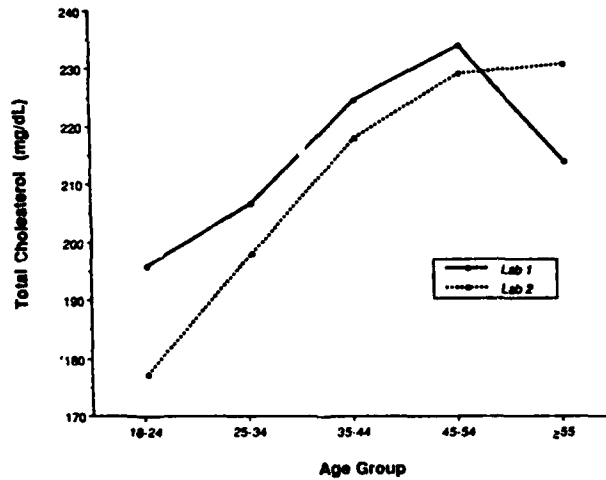
Table 3 presents mean blood lipid values for each laboratory and for the sample as a whole. When the sample (mean age=33.6 yrs) was age-adjusted to be representative of the Navy at large, the overall mean cholesterol level was 196 mg/dL; the unadjusted mean was 208.2 mg/dL. Lab 1 was significantly higher than Lab 2 on total cholesterol (212.8 mg/dL and 205.7 mg/dL, respectively), yet was also somewhat higher on HDL (50.8 mg/dL vs. 48.7 mg/dL) and slightly lower on the TOTCHOL:HDL ratio (4.4 vs. 4.5). As shown in Figure 1, mean cholesterol levels at both laboratories were higher at each succeeding age group until age 55 and older, though the values reported for the oldest group are somewhat unreliable because of the reduced cell sizes. Overall prevalence of risk also was computed for the age-adjusted sample, using the Navy cutpoints; results indicated that 30% were at risk (unadjusted rate=37%).

TABLE 3
MEAN BLOOD LIPID VALUES: OVERALL AND BY CLINIC

Variable	Lab1	Lab 2	Total	t	df	p<
TOTCHOL (mg/dL)	212.8	205.7	208.2	5.85	5340	.000
LDL (mg/dL)	133.8	131.5	131.8	1.23	3852	n.s.
HDL (mg/dL)	50.8	48.7	49.0	4.05	4048	.000
TRIG (mg/dL)	134.2	130.8	131.9	1.23	5245	n.s.
TOTCHOL:HDL	4.3	4.5	4.5	-2.00	3909	.046

Figure 1.

Mean Total Cholesterol by Age Group and Lab



Mean TOTCHOL values for the entire sample were recomputed using Blair *et al.*'s⁷ age categories, and the results, compared with Blair *et al.*'s findings, are shown in Figure 2. The pattern of cholesterol rising with age was the same for both samples until the oldest group (>50 yrs), where the Blair *et al.* study reported a continuing increase in TOTCHOL as contrasted with a slight decrease in the present study. Cholesterol levels in the present study were substantially higher than Blair *et al.*'s in every age group.

Figure 2.

Mean Total Cholesterol by Age Group in Two Navy Samples

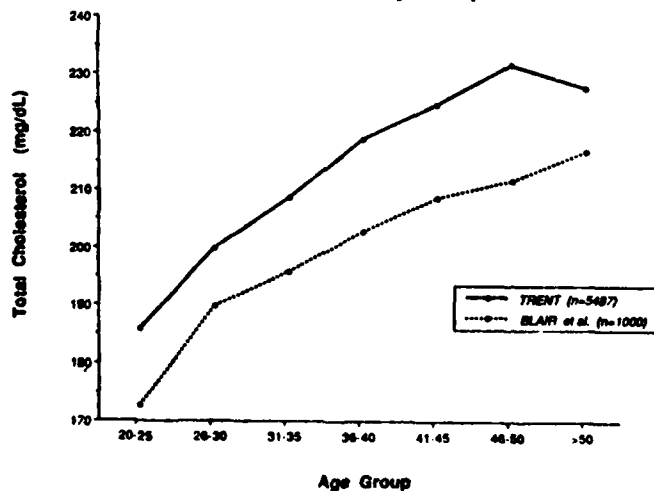


Figure 3 presents mean cholesterol values across age groups for men and women. Because of insufficient cell sizes, no data are presented for women over 44 years of age ($n=8$), and the value for men in the ≥ 55 age group ($n=25$) should be interpreted cautiously. In the youngest age group, the mean for women (188 mg/dL) was slightly higher than that for men (183 mg/dL), but the means coincided (201 mg/dL) in the next age group. At that point, men's mean cholesterol rose sharply to 220 mg/dL, while the women's ($n=96$) dropped slightly to 199 mg/dL. The men's level continued to rise to 230 mg/dL in the 45-54-year-old age group, after which it dropped somewhat to 224 mg/dL in the oldest group. The pattern for LDL-cholesterol was very similar (Figure 4), except that the men's mean surpassed the women's in the 25-34-year-old group and continued to rise to a peak of 151 mg/dL in the oldest group ($n=20$).

Figure 3.

Mean Total Cholesterol by Age Group and Sex

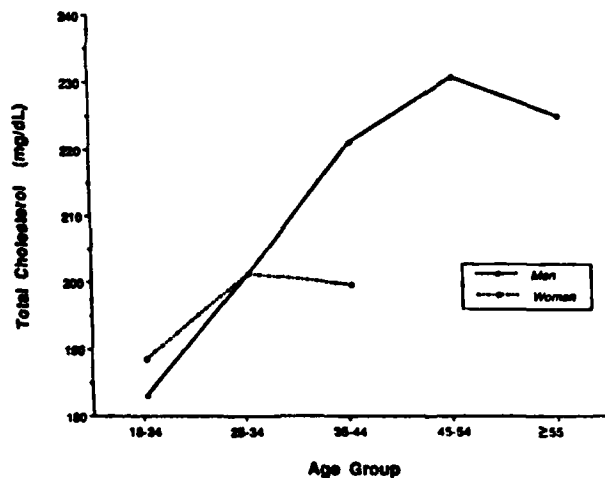
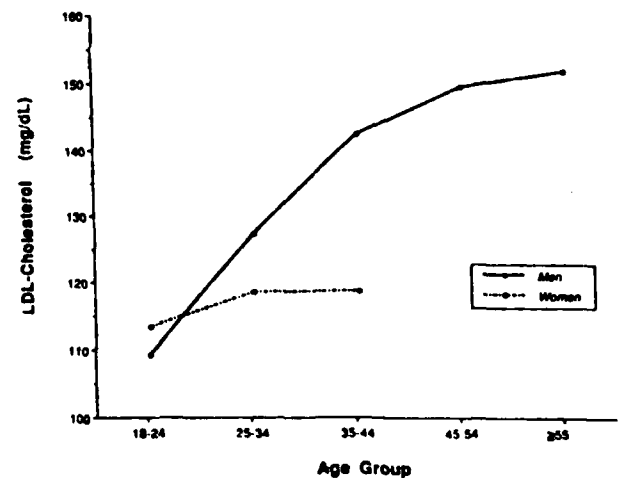


Figure 4.

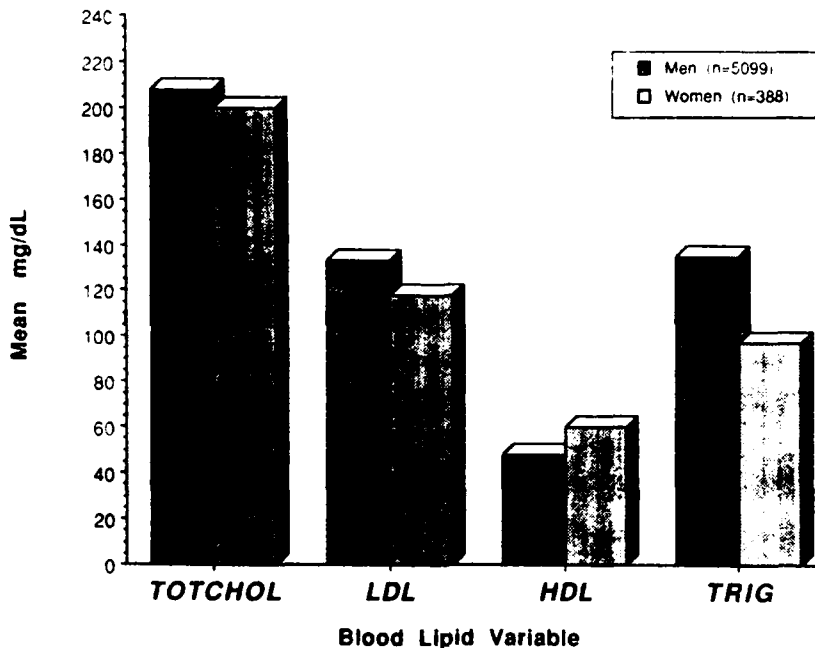
Mean LDL-Cholesterol by Age Group and Sex



Overall mean values for TOTCHOL, LDL, HDL, and TRIG for both men and women are shown in Figure 5. Men were significantly higher than women on LDL (133 mg/dL and 118 mg/dL, respectively) and TRIG (135 mg/dL vs. 97 mg/dL), and significantly lower on HDL (48 mg/dL vs. 60 mg/dL). Men exceeded women on TOTCHOL as well (209 mg/dL vs. 200 mg/dL), but the difference only approached significance ($p<.06$). It should be noted that these data include the entire sample, ages 18-61, and that women are

Figure 5.

Mean Blood Lipid Values by Sex (Ages 18-61)



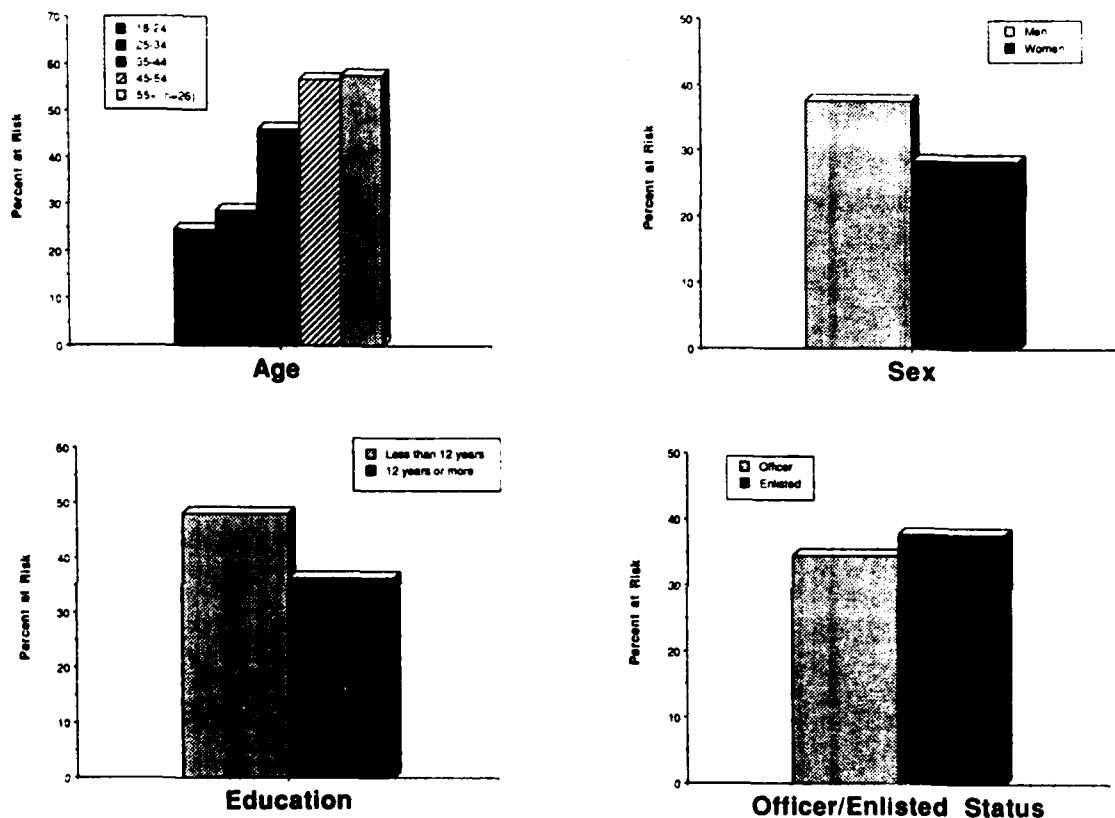
underrepresented in the older age groups. However, the analysis also was conducted for subjects 44 years of age and younger, and the results were almost identical to those presented in Figure 5.

Prevalence of Risk

Using the Navy risk cutpoints for total cholesterol values (>200 mg/dL for those 18-24 years of age, >220 mg/dL for those 25 and older), prevalence of risk was computed for several subgroups (all ages included). Significant group differences are graphed in Figure 6. The most striking differences in risk prevalence occurred across age groups, where the percent at risk climbed from 25% in the youngest age group to 58% in the oldest ($p<.001$). Among those with less than a high school education, prevalence of risk was 48%, versus 36% among those with 12 years of school or more ($p<.001$). Focusing on sex differences, nearly 38% of all men were at risk, compared with 28% of all women ($p<.001$). And though the observed difference was

Figure 6.

Group Differences in Overall Percent with Total Cholesterol Levels at Risk (Navy Cutpoints)



small, more enlisted personnel were at risk than were officers (38% and 35%, respectively, $p < .04$). No significant differences were found for race or community (ship/shore).

As mentioned above in conjunction with laboratory differences, the overall prevalence of risk (on TOTCHOL) for the sample was 36.9%. Percent at risk also was computed for each of the other lipid variables, with the following results: LDL (>130 mg/dL)=48.4% at risk; HDL (<35 mg/dL)=9.1%; TRIG (>250 mg/dL)=8.3%; and TOTCHOL:HDL ratio (>5.0)=28.7%. Although triglyceride level and the TOTCHOL:HDL ratio generally are not independent predictors of CHD risk, the LDL- and HDL-cholesterol fractions are both

important independent risk factors. Therefore, prevalence of risk was computed, taking into account all three major factors: TOTCHOL, LDL, and HDL. Results are shown in Figure 7. The cross-tabulation was based on 3,829 people who had data for all three variables. The overall percent with TOTCHOL values at risk in this smaller sample was 34.8% (versus 36.9% for the entire sample). However, if those with acceptable TOTCHOL but elevated LDL- or low HDL-cholesterol are included in the risk calculation, an additional 19.4% would be considered at risk (3.6% with low HDL, and 13.7% plus 2.1% with high LDL), bringing the overall total to 54.2%. The pie chart depicts the percent of the total sample ($n=5,487$) at risk on any one, two, or all three of these risk factors. In this group, 49.7% of the sample were found to be at risk on at least one factor.

Figure 7.

Augmentation of Risk Estimate: LDL and HDL Added to TOTCHOL

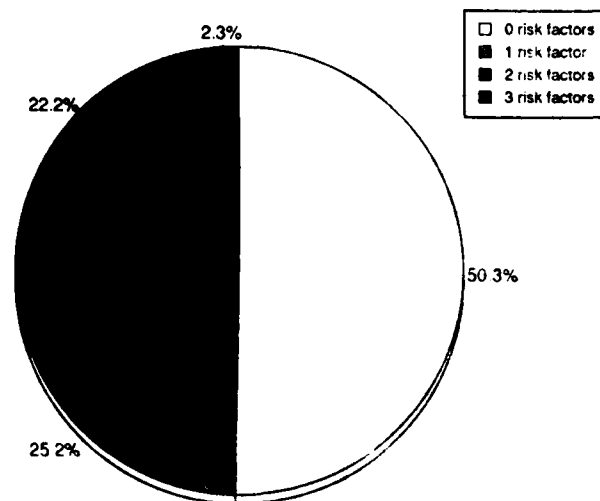
TOTCHOL by LDL by HDL (N=3829)

		HDL	
		Acceptable	Low
LDL	Acceptable	1.9%	.3%
	Elevated	29.3%	3.3%

TOTAL CHOLESTEROL at Acceptable Level

		HDL	
		Acceptable	Low
LDL	Acceptable	45.9%	3.6%
	Elevated	13.7%	2.1%

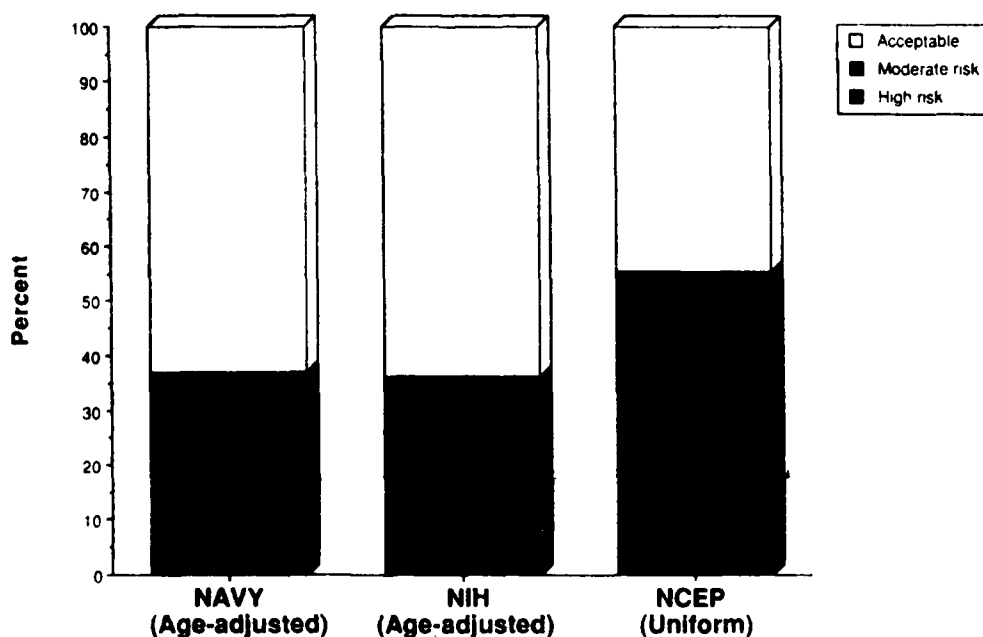
Percent at Risk on One or More Major Risk Factors:
TOTCHOL, LDL, HDL (N=5487)



To further explore the variability of results obtained with different gauges of risk, the same TOTCHOL values were analyzed using the three sets of risk cutpoints outlined in Table 1. All ages were included in this analysis. Results are presented in Figure 8, which compares the percent at risk when using the Navy cutpoints to results obtained with the NIH age-adjusted and NCEP uniform cutpoints. While the total percent at risk using the Navy standards was almost identical to the NIH age-adjusted results (36.9% and 36.2%, respectively), the Navy cutpoint results were considerably lower than those obtained with the NCEP uniform cutpoints (55.4%). It should be noted that although the Navy makes no distinction between moderate and high risk levels, all 36.9% were defined as "moderate risk" for this graph. Using the NIH standards, 15.8% were at moderate risk and 20.4% at high risk; using the NCEP guidelines, 33.7% were at moderate risk and 21.7% at high risk.

Figure 8.

**Percent with Total Cholesterol Levels at Risk (Ages 18-61):
Comparison of Navy vs. NIH vs. NCEP Cutpoints**



Comparisons with National Norms

Because national norms (from NHANES II) utilized the NIH age-adjusted risk levels, the following comparisons between Navy percentages at risk and those nationwide were based on the NIH cutpoints. Figure 9 shows mean total cholesterol values across age groups for both men and women (up to age 54 for men, 44 for women), Navy versus national samples. The pattern of rising cholesterol with age was the same for both Navy men and NHANES II men, the mean values being consistently about 3 points higher in the Navy sample. Among women, however, the pattern was different. The observed steady rise in cholesterol with age was seen in the NHANES II women, but among Navy women, whose cholesterol levels were higher than the national norms in the first two age groups, the mean values remained essentially level between the 25-34 and the 35-44-year-old age groups.

Figure 9.

Mean Total Cholesterol by Age and Sex: Navy vs. Nation (NHANES II)

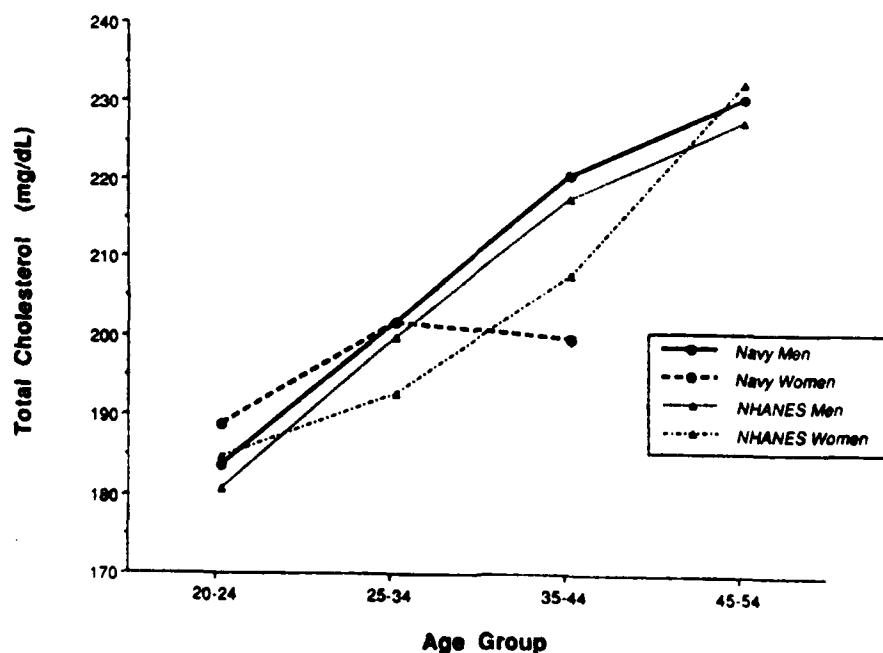
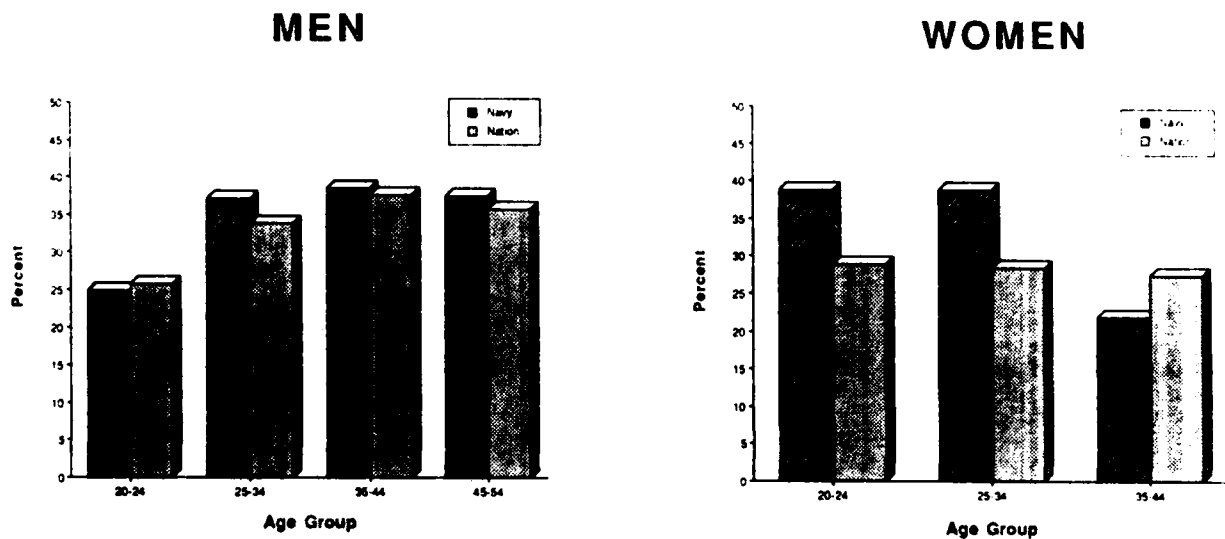


Figure 10.

**Overall Percent with Total Cholesterol Levels at Risk,
By Age and Sex: Navy vs. Nation (NHANES II)**

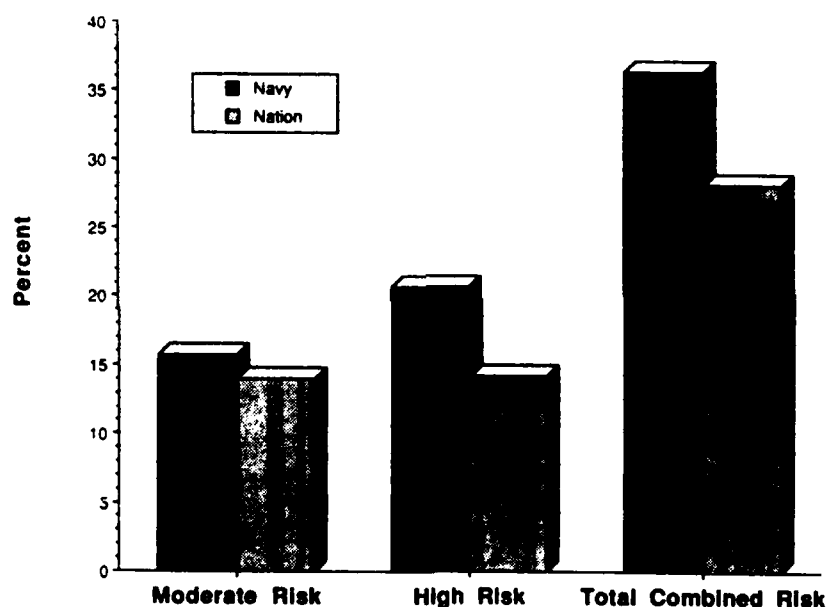


In examining the percent at risk for these groups (Figure 10), it can be seen again that results across age groups for the men were very similar between the two samples, but very different between Navy and NHANES II women. The percent of men at risk increased in both samples until age 44, at which point it dropped slightly in the oldest age group. Fewest men were at risk in the youngest age group (24.9% Navy, 25.7% nation), while the peak percent of men at risk (occurring at ages 35-44) was 38.5% for the Navy and 37.6% for the nation. The pattern for women was quite different in that the peak percent at risk was in the youngest age group (38.3% Navy, 28.9% nation), and the lowest percent at risk was in the oldest (35-44 yrs) group (21.8% Navy, 27.4% nation). However, the national sample exhibited a flat distribution across age groups as opposed to the Navy women's pronounced drop in percent at risk in the highest age group.

In Figure 11, men and women ages 20-44 were combined to show the overall distribution of risk in the two samples. The Navy was significantly higher than the nation in total percent at risk: 36.4% at risk compared with the nation's 28.2% ($\chi^2=78.38$, $p<.001$). While the Navy surpassed the nation for both moderate and high risk, the difference was particularly pronounced in the high risk category, with 20.7% for the Navy sample versus 14.2% for the national norms.

Figure 11.

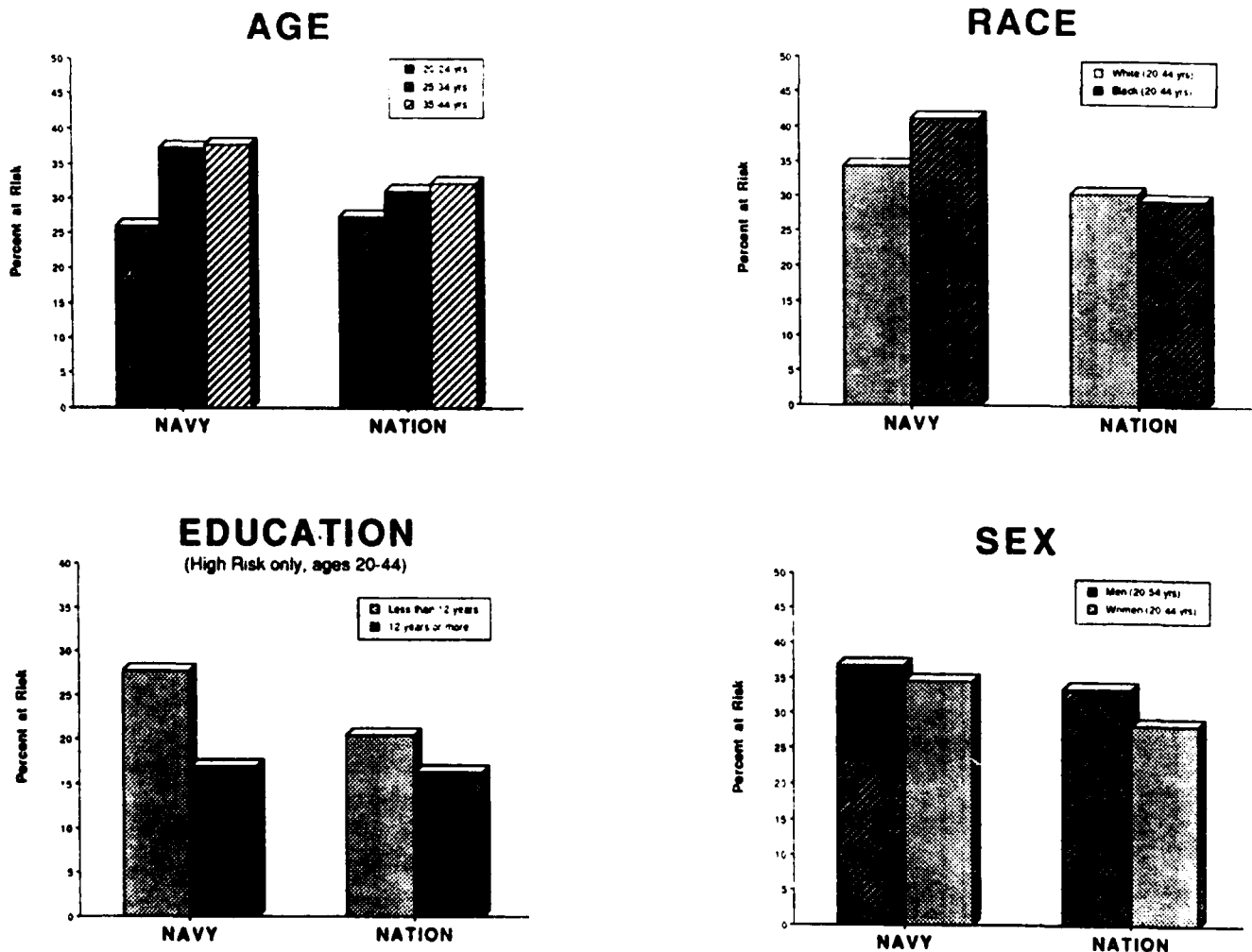
**Distribution of Total Cholesterol Risk Levels (Ages 20-44):
Navy vs. Nation (NHANES II)**



Group differences in risk between the Navy and national samples are shown in Figure 12. In addition to age, the three demographic variables for which comparable data were available in both samples were education, race, and sex. The percent at risk increased significantly across age groups in both samples (ages 20-44 only), starting at a lower point among Navy participants (25.9% vs. 27.4%) but ending at a higher point (37.7% vs. 32.2%). Education data were available only for the percent at high risk in the NHANES II sample, so the Navy data presented are likewise limited. In

Figure 12.

Group Differences in Overall Percent with Total Cholesterol Levels at Risk: Navy vs. Nation (NHANES II)



both samples (ages 20-44), those with less than 12 years of education were more likely to be at high risk (27.7% Navy, 16.9% nation) than were those with a high school diploma or higher (20.4% Navy, 16.3% nation). After controlling for age, this difference was still significant in the Navy sample ($p < .001$), but not in the national sample. Racial differences in percent at risk (ages 20-44) were greater in the Navy than in the national

norms. In the Navy, 41.1% of Blacks were found to be at risk, compared with 34.3% of Whites ($p < .01$); corresponding values for the nation were 29.4% and 30.4%, respectively (n.s.). (It will be recalled that no race differences were found when using the Navy cutpoints.) Sex differences were examined for men ages 20-54 and women ages 20-44. In both the Navy and NHANES II samples, a larger percent of men were at risk than were women (36.7% men vs. 34.4% women in the Navy; 33.4% vs. 28.2% in the nation.)

Discussion

In general, serum cholesterol levels found in this Navy sample were somewhat elevated across age groups, though the age-adjusted mean was within the standards recommended by the National Cholesterol Education Program panel. It should be noted that the sample was not representative of the Navy at large, but only of those individuals undergoing routine physical examinations, which underrepresents younger service members. There was a significant difference in means between the two laboratories providing data for the study, though both had means above 200 mg/dL. The cholesterol values found across age groups were higher than those reported by Blair *et al.* in their 1986 Navy sample⁷ and somewhat higher than those found nationwide in the 1976-1980 NHANES II.⁴ Mean LDL-cholesterol was above the recommended level for men, but not women. Interestingly, Navy women in the 35-44-year-old age group showed a definite departure from the overall pattern of increasing cholesterol values with age. Further research could explore some of the reasons for this finding.

In terms of percent at risk, about 37% of the unadjusted sample (30% age-adjusted) were above the Navy risk cutpoints, and if LDL and HDL risk were counted as well, approximately 55% would be at risk--the same as when using the uniform cutpoint of 200 mg/dL for total cholesterol alone. A cross-tabulation was performed for LDL risk by HDL risk by TOTCHOL risk as determined by the NCEP guidelines, and the results were compared with those presented in Figure 7 (which were based on the Navy guidelines). Only 6.6% of those with acceptable total cholesterol levels (< 200 mg/dL) were

nevertheless at risk on LDL- or HDL-cholesterol or both, compared with 19.4% when TOTCHOL risk was determined by the Navy cutpoints, suggesting that the lower TOTCHOL cutpoint might be more useful in risk screening.

These differences, both between samples and within the same sample, illustrate some of the difficulties encountered in cholesterol screening that have yet to be resolved. Perhaps the most important is the lack of standardization. It is not known why the two laboratories in this study produced significantly different results. It is known that one lab used an analyzer that has been found to be positively biased with respect to the Lipid Research Clinics results, and that the other lab used different instrumentation. Such findings (concerning bias) need to be replicated, however. It is not known why the present findings were so much higher than Blair *et al.*'s, which were processed at a different naval hospital than the labs in this study. A possible explanation, again, is that different equipment and laboratory methods were used. The results presented here cannot be accurately interpreted or adequately discussed until the raw data have been proven valid and reliable. Navy laboratories need to standardize their methods of cholesterol level determination, and ideally this would be accomplished via external quality control procedures to quantify and correct bias with respect to the LRC standard.

Another important issue is the choice of risk cutpoints, which is as much a management strategy as a medical decision. Very different results are obtained using age-adjusted rather than uniform cutpoints, and different results again if LDL and/or HDL risk levels are included in the calculation. One problem in choosing appropriate cutpoints is that cholesterol research is still quite young. The complex associations among various lipid factors, their interactions with demographic, genetic, or other risk factors, and their impact on coronary heart disease are not well understood. Prospective studies are needed to determine the impact of cholesterol guidelines on the population. The value of any given cutpoint strategy will depend in part on the relative percentages of resultant false positives and false negatives, and on decisions which weigh the costs of each. In attempting to develop their own cholesterol risk cutoff values for an Army sample (mean age=39

yrs), Keniston and his associates¹¹ concluded that "the best combination of sensitivity and specificity (85% and 87%, respectively) occurred at a [total cholesterol] of 220 mg/dL" (p. 53). But if, for example, the cost of a false negative is higher than the cost of a false positive, the "best combination" may not be an equal balance but rather one that favors sensitivity. On the other hand, when half of the population is determined to be at risk, health providers responsible for intervention and treatment must set priorities and ask, "How much risk?" The practice of classifying risk into "moderate" and "high" categories helps guide treatment decisions as well as alerting patients to their own risk status; it should perhaps be adopted by the Navy.

Public concern about cholesterol and its potential health effects has increased tremendously, but the predictable backlash¹² could destroy public confidence in even the most sensible recommendations by such agencies as the NCEP. Careful research will dispel the confusion and provide the foundation for optimal screening and treatment programs. The Navy has two advantages in this arena: access to medical and fitness data for an entire population, and complete or nearly complete lipid profiles for all of its members. Once the problem of laboratory standardization has been addressed, and much-needed automation of medical records has been accomplished, researchers can begin to fill in the gaps left by this preliminary report.

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<p>The U.S. Navy is seeking to reduce the incidence of cardiovascular disease among its members by identifying and treating individuals with elevated serum cholesterol. The primary purpose of this study was to estimate the prevalence of hypercholesterolemia in the Navy. Fasting blood lipid profiles were collected for 5,487 active duty men and women presenting for routine physical examinations. Mean serum cholesterol for the age-adjusted sample was 196 mg/dL. Cholesterol level increased with age and was higher in men than in women. Using Navy cutpoints (>200 mg/dL for ages 18-24, >220 mg/dL for ages >25) to determine risk on total cholesterol (TOTCHOL), about 30% of the age-adjusted sample (37% unadjusted) were found to be at risk. This rate would increase if risk on LDL- and HDL-cholesterol were taken into account as well. Prevalence of TOTCHOL risk in the Navy was higher than in a national sample. Two issues that need to be addressed are (a) lack of standardization among Navy laboratories and (b) choice of risk cutpoints for determining individual risk and general risk prevalence rates.</p>				
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